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MEDICAL RESEARCH LABORATORY



U.S. Naval Submarine Base
New London

1942

PRELIMINARY REPORT

on

COLOR VISION TESTING

Project V5-2

COLOR VISION REPORT NO. 1

Medical Research Laboratory Report No. 7

September 12, 1942

Medical Research Division

U.S.N. Submarine Base, New London, Conn.

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PRELIMINARY REPORT ON COLOR VISION TESTING

On June 11, 1942 project V5-2 was assigned to the Medical Research Division, Submarine Base, New London, Connecticut, by the Research Division of the Bureau of Medicine and Surgery, Washington, D.C. The description of the project, as contained in the assignment from the above Bureau, was: "Trial of Royal Canadian Navy Colour Vision Lantern in comparison with other color vision tests available at Submarine Base, New London. Project in exploratory stage under direction of Dr. Shilling. A problem under joint cognizance of Aviation and Submarine Sections of Research Division."

Pursuant to these instructions, research is being conducted using the following equipment:

- (1) The Pseudo-isochromatic plates manufactured by
The American Optical Company,
- (2) The Royal Canadian Navy Colour Vision lantern,
- (3) The Farnsworth panel,
- (4) The Inter-Society Color Council Series 4-A "designed
for testing color blindness",
- (5) The Edridge-Green Lamp,
- (6) The Vision Color Test Wools, and
- (7) The Jensen chart.

The subjects for this study are drawn from three sources:
(1) the U.S. Navy men who are candidates for Submarine School reporting for physical examination, (2) the civilians who are candidates for enlistment in the Marine Corps and are having their preliminary examination at the Submarine Base Dispensary. (3) the civilians who are candidates for Civil Service appointments and are reporting for physical examination at the U.S. Naval Submarine Base Dispensary.

This group includes both men and women. The two latter groups are a good cross-section of the civilian population. On all groups we record not only the results of the tests, but also the individual's age, education, color of eyes, visual acuity, and the time required for the completion of the tests. On the submarine school candidates we record also the I.Q. (as measured by the Otis Self-Administering Test of Mental Ability), and any pertinent physical and neurological information.

The technical work on this project is being conducted by REED, John David, Ph.M.Sc., who came to this activity from the Graduate School of Brown University. The tests are all conducted in the same Laboratory, and by the same technician, and in strict accordance with the instruction laid down by the manufacturers of the equipment.

FURTHER DESCRIPTION OF THE TESTS:

(1) The American Optical Company's Pseudo-Isochromatic plates are the present standard test for color vision in the Navy, therefore no detailed description is necessary. These plates resemble the Ishihara and Stillings plates formerly used by the U.S. Navy, which are no longer available because of the international situation. We have standardized the administration of the A.O. plates, using a distance of three feet and an illumination of 10-foot candles from a "daylight" lamp. Prompting, correcting, and other assistance sometimes adopted in the administration of this test, is avoided and the response is recorded without comment. The subject is allowed up to 20 seconds to consider each plate before responding. The instructions for reading the plates are merely, "Read the numbers down this page." With the plates containing lines which are to be traced, the examiner determines that the subject can or cannot see the line. The responses are recorded verbatim.

(2) The Royal Canadian Navy Colour Vision Lantern

presents nine combinations of pairs of red, green, and white light. All the filters are of polished Pyrex glass. The green filter is the standard signal green (Corning No. 440), the red filter is a deep red (Corning No. 241), and a colorless polished Pyrex (Corning No. 774) is used for the white. The lantern shows two horizontally disposed lights at a time. These are spaced 1" apart and a movable diaphragm permits the use of apertures which are either 0.2" or 0.02" in diameter. The larger apertures are used for demonstration and the smaller for test purposes. The individual tested is given one or more trials to identify the combinations correctly. The only deviation allowed is that the white light may be called "yellow", since the "white" has a distinctly yellow cast. These lights are designed to represent the running lights of a vessel of 25-foot beam at 2000 yards.

(3) The Farnsworth color panel was recently designed by Dr. Dean Farnsworth of New York University and consists of 35 color buttons which differ by equal amounts of color all through the spectrum. These buttons are set up in four long, narrow trays, with a fixed pilot button at either end of each tray. In each tray, color gradations with equal chromaticity differences are represented by twenty-odd identically constructed buttons. These buttons are to be arranged in proper order so as to make an even gradation of color from one pilot button to the other. The underside of each button is numbered so the test can be scored by turning the buttons over and observing whether or not they are in proper order. Graphic presentation is possible on a specially designed chart. (see illustrations #9, #10, #11, #12)

The test is scored by noting the numerical differences between a button and the ones on either side of it. These two differences are then added and the sum is the score for that color button. For instance, if the order of a series is ---26, 28, 27---, then 28 is 2 units from 26 and one from 27 giving a total of 3 units. If the test is

correctly arranged the score is 2 units to every button.

(4) The Inter-Society Color Council has developed a special series of 15 chips designated as 4-A, "designed to test color blindness." These are to be arranged from pink to gray and thence to purple. The operator may place a standard color chip at either end and one in the middle and have the subject arrange the remaining chips to show the proper gradations of color; or the subject may be asked to match one set with another properly arranged set.

(5) The Edridge-Green lamp is another test for color blindness used routinely in the Navy as the final authority for determining officers' color vision. It consists of four wheels, ---three carry six colored glasses each (Red A and B, Yellow, Green, Signal Green, Blue and Purple), and one hole; and the fourth has a modifying lens, which may be one of the following: Ground glass, Ribbed glass, Neutral #1, Neutral #2, Neutral #3, Neutral #4, or Neutral #5. The three primary colors, plus signal green, blue and purple may be presented individually or in a great variety of combinations and in varying degrees of luminosity. The size of the aperture permitting egress of the light may be varied also.

(6) The Vision Color Test set of Wools, as available from the Naval Medical Supply Depot, is used in accordance with the accepted practice of matching these vari-colored yarns.

(7) The Jensen test is a chart on which is shown the faces of Four clocks each showing colored hands in various positions. These are pseudo-isochromatic plates similar in principle to the American Optical Company's plates.

The American Optical Company's pseudo-isochromatic plates are at present the most widely used test for color perception in the U.S. Navy. We had expected to use these plates as a standard for comparison with the Royal Canadian Navy Colour Vision test.

However, we found the American Optical Company's plates to be so indefinite and confusing and the responses of known color-normal individuals were so variable and lacking in decision as to necessitate an exhaustive study of these plates. This paper is principally a presentation of the results of this phase of the study.

RESULTS:

In reading the A-O plates, the majority of the 438 individuals included in this study (who actually had normal color vision), made an inordinate number of errors in calling the plates. Illustration No. 1 shows, in graphic form, that less than 6% had a perfect score, whereas the average number of mistakes per person was 5.1, and the greatest number of errors was 19. No individual was included in this part of the study who was considered to be color-weak or color-blind (i.e. no one was included who made any significant errors in the "confusion plates").

Individuals who were rechecked for any reason are not included in the above class. The rechecks fall into three groups: (1) Those who upon re-examination with the entire battery of tests were passed as normal, or somewhat color-weak; (2) Those who failed the Royal Canadian Navy Colour Vision Lantern, but were accepted for submarine duty -- often because of previous naval experience rendering them of sufficient value to the Service to compensate for this defect; and (3) those whose color perception was so sub-normal as to necessitate rejection for the submarine service. On the basis of our color tests, the subjects classified in Groups 2 and 3 should not have been enlisted in the U.S. Navy.

Illustration No. 2 is a tabulation of these three groups of rechecked individuals. These are subjects who gave an equivocal performance and were considered to be of sufficient interest to retest them on the other tests in our group. It will be noted here

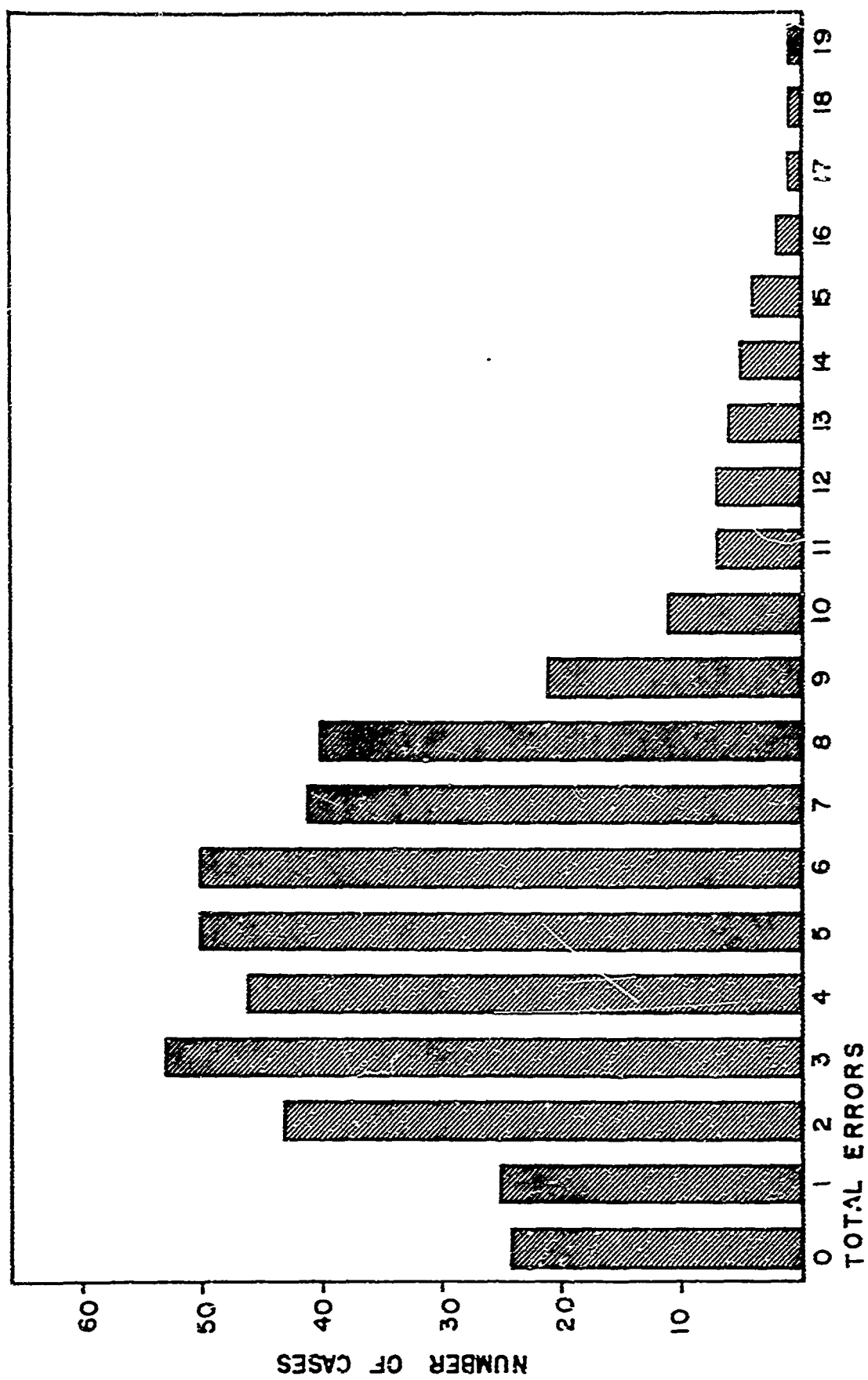


ILLUSTRATION NO. 2

The following table presents the total number of errors on the American Optical Company's plates made by those individuals who were rechecked: --

Number of Errors	GROUP #1 Retested Normal or color-weak	GROUP #2 Failed R.C.N. Lantern	GROUP #3 Re- jected: Color-blind
5	1		
6	2		
9	4		
10	1		
11	1		
15	2		
18	1		
20	1		
21	1	2	
23	1	1	
25		1	1
26	2		
29		1	
30		1	1
31			2
34			1
35	1		
36			1

that the scatter is in a different area, -- the least number of errors was 5, the average number of errors was 20.5, and the greatest number was 36.

Illustration No. 3 presents in tabular form all of the errors made by our 438 "normal" subjects on each of the A.O. plates, - for example, for Plate #7 the correct answer is 39; however, 275 of the 438 subjects miscalled this plate, as follows: 267 individuals called the figure 89, five called it 80, one called it 98, one called it 33, and one called it 30. No errors were made on plates #25, #26 or #46, which are designed to test malingering. It is significant that no errors were made on plates #15, 16 and #5, #6 or #41, which are confusion plates designed to detect red-green color blindness. There were no errors on Plate #35 or #36, both of which show lines easily followed by the person of normal vision, but rarely by the red-green blind individual. This tabulation confirms the fact that the individuals included in this part of the study were normal, insofar as color perception is concerned.

Illustration No. 4 is a graphic presentation of the material recorded on Illustration No. 3, and is designed to present a comprehensive picture at a glance. The ordinate is the number of errors and the abscissa is the plate number and shows the correct response. In each column we have grouped the incorrect responses given and have labelled them if they total five or more. For example, for Plate #30 the normal response should be 75, whereas seventy individuals called the number 25, fifteen called the number 76, ten individuals called it 85, nine people did not know what the number was, eight called it 26, and the rest gave various other responses which are grouped together in the uncolored section of the column.

Illustration No. 5 shows the interpretation of the Pseudo-Isochromatic plates for testing color perception, as it is given in the Manual furnished by the American Optical Company. This is an

ILLUSTRATION NO. 3

The following table is an analysis of all of the errors made on each A-O plate by 438 subjects.

Plate #	Cor. Resp.	Total Errors	Breakdown of errors according to numbers miscalled and by how many.							
*1	89	3	80 1	88 1	98 1	(That is, one person called it 80, one 88, and one 98)				
*2	43	196	89 193	68 2	18 1					
*3	56	4	66 4							
*4	27	35	22 22	28 5	29 4	87 1	27 1	23 1	25 1	
5	8	0								
6	3	0								
*7	39	275	89 267	80 5	98 1	33 1	30 1			
*8	42	22	48 9	62 4	22 3	12 2	47 1	52 1	82 1	58 1
*9	56	2	58 2							
*10	27	30	22 14	29 12	28 3	20 1				
11	29	118	20 111	28 3	79 2	70 1	26 1			
12	57	26	37 25	35 1						
*13	86	1	88 1							
*14	75	63	76 34	85 11	25 9	26 4	95 2	96 1	78 1	? 1
15	7	0								
16	9	0								
*17	25	8	26 4	85 3	25 1					
*18	68	7	88 5	45 1	63 1					

*See Illustration No.7 for a further analysis of the errors on this plate.

ILLUSTRATION NO. 3

(continued)

Plate #	Cor. Resp.	Total Errors	Breakdown of errors according to numbers miscalled and by how many subjects.											
19	5	4	8	2										
			3	1										
20	3	6	5	8										
			4	2										
*21	97	12	87	98	96	92	27							
			6	3	1	1	1							
*22	34	78	84	85	35	64	80	54	35	33	83			
			59	7	5	2	1	1	1	1	1			
*23	96	5	65	86	63	46								
			2	1	1	1								
24	27	58	22	28	29	88	97	87	99	29				
			30	13	9	2	1	1	1	1				
25	12	0												
26	H	0												
*27	89	10	88	29	?	82	8?							
			4	2	2	1	1							
*28	43	190	48	68	63	98	47	23	28	?				
			178	6	1	1	1	1	1	1				
*29	85	18	88	96	46	36	26	85	?					
			8	4	2	1	1	1	1					
*30	75	122	25	76	85	?	26	95	75	88	83	23	62	
			70	15	10	9	8	2	2	2	2	1	1	
*31	52	43	62	58	32	59	82	68						
			28	7	2	2	2	2						
*32	96	2	86	98										
			1	1										
33	--	144	45	25	35	43	47	65	47	34	46			
			124	4	4	3	3	3	2	1	1			
34	--	143	73	75	23	25	29	27	78	28	72	79	76	
			61	33	21	12	6	3	2	2	1	1	1	
35	line	0												
36	line	0												

*See illustration No. 7 for a further analysis of the errors on this plate

ILLUSTRATION NO. 3

(continued)

Plate #	Cor. Resp.	Total Errors	Breakdown of errors according to numbers mis-called and by how many subjects.													
*37	052	17	062	952	292	252	056	852	032							
			10	2	1	1	1	1	1							
*38	394	199	894	896	294	797	884	233	804	895	395	594				
			184	5	3	1	1	1	1	1	1	1				
39	23	223	28	25	?	88	83	29	93	26	27	93	93			
			175	10	10	8	6	4	4	2	2	1	1			
40	65	98	?	68	66	05	63	69	65	85	67	88	89	75	67	06
			25	21	20	14	5	2	2	1	1	1	1	1	1	1
41	15	0														
42	74	6	24	71												
			4	2												
43	47	60	43	42	46	?	40	27	49	87	67	57	17			
			13	13	12	8	5	3	2	1	1	1	1			
44	98	73	?	95	93	68	88	08	92	78	94	97	95	83	28	05
			14	11	10	9	8	6	3	3	2	2	1	1	1	1
45	--	49	line													
			49													
46	line	0														

* See Illustration No. 7 for a further analysis of the errors on this plate.

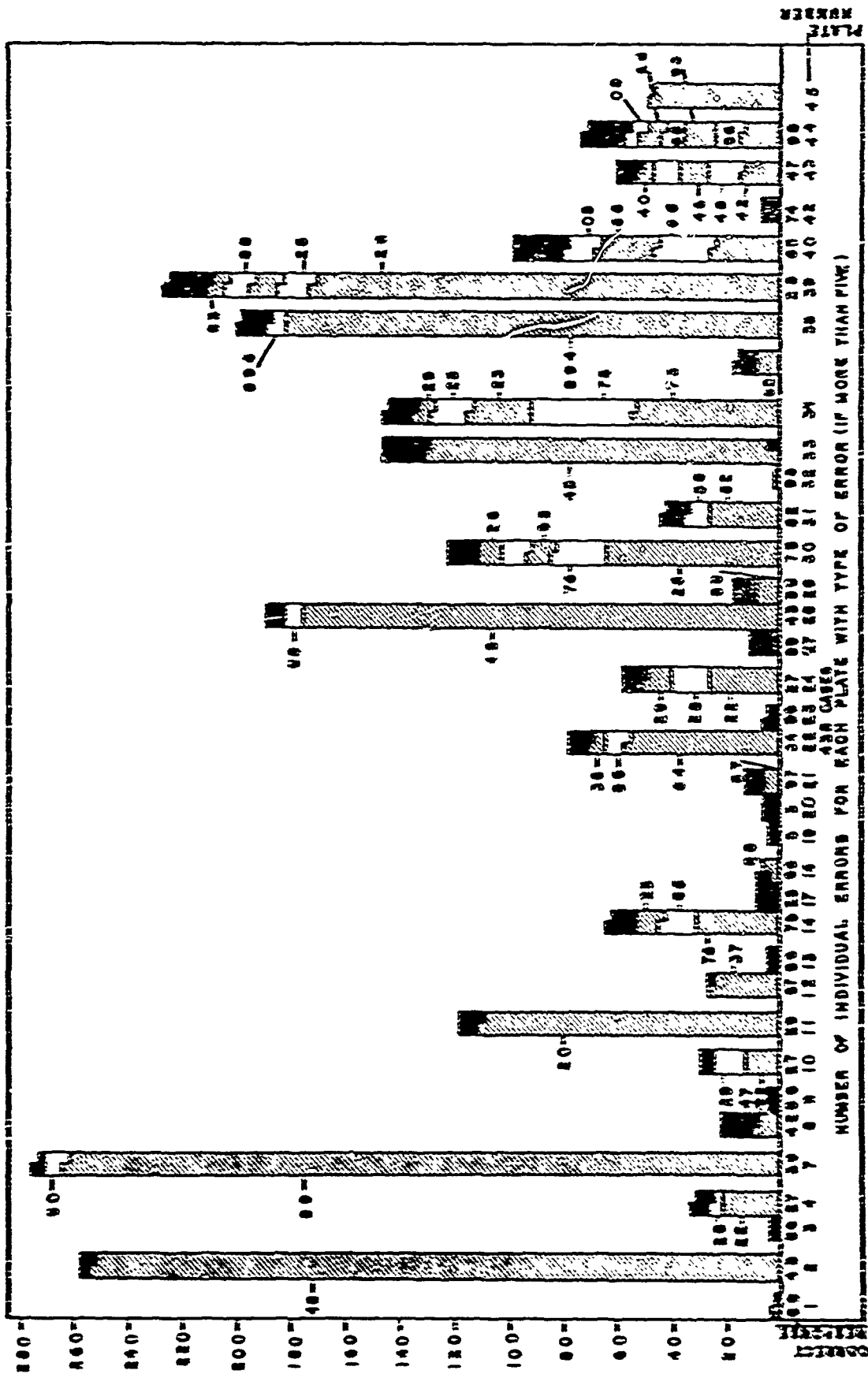


ILLUSTRATION NO. 5

**INTERPRETATION OF PSEUDO-ISOCROMATIC
PLATES,**
as given in the manual furnished by the American
Optical Company.

PLATE NO.	NORMAL PERSON READS	RED-GREEN BLIND READS
1	89	Rarely
2	43	Rarely
3	56	Rarely
4	27	Rarely
5	8	3
6	6	5
7	39	Rarely
8	42	Rarely
9	56	Rarely
10	27	Rarely
11	29	70
12	57	35
13	86	Rarely
14	75	Rarely
15	7	Rarely
16	9	Rarely
17	25	Rarely
18	68	Rarely
19	5	2
20	3	5
21	97	Rarely
22	34	Rarely
23	36	Rarely
24	27	Rarely
25	12	12
26	H	H
27	89	Rarely
28	43	Rarely
29	86	Rarely
30	75	Rarely
31	52	Confusion Nos.
32	96	Confusion Nos.
33	Rarely	45
34	Rarely	73
35	Follows Line	Rarely
36	Follows Line	Rarely
37	052	Confusion Nos.
38	394	Confusion Nos.
39	23	Rarely
40	65	Rarely
41	15	17
42	74	21
43	47	Rarely
44	98	Rarely
45	Rarely Follows Line	Easily Follows Line
46	Easily Follows Line	Easily Follows Line

exact copy of the table in the manual and is given simply as a ready reference.

Illustration No. 6 is self-explanatory and is given for purposes of comparison with our results.

Certain plates in Illustration No. 3 are marked with an asterisk and the digits on these plates are subjected to further analysis in Illustration No. 7. These are the plates in which the formation of the digits is unusual, for example, the seven appears thus, ; the two, so -- and the three, so -- . In this table the total possible errors are calculated by multiplying the number of times the digit appears by the 200 individuals reading the same, -- thus the number two appears eight times and multiplying this by 200 equals 1600 possible errors.

The unequal occurrence of these total possible errors has been adjusted to a percentage basis and is presented in Illustration No. 6. Thus three is called eight 502 times out of a possible 1200 times, or 41.8% of the times, etc. It is noteworthy that three is called eight because of the close resemblance between the type of three presented in the various plates and a typical eight. Errors of this nature certainly cannot be considered due to defective color perception. It is much more likely that they are due to the atypical formation of the figures on the plates. All confusion factors in a color vision test should be confined to the color element and every effort should be made to control other factors, such as intelligence, previous experience, etc.

Our work so far indicates that the use of the American Optical Company's Test for Color Perception (strictly interpreted and given without assistance) designates as color-blind a far greater percentage of individuals than actually have this deficiency. It is perfectly possible to materially raise the performance by coaching.

ILLUSTRATION NO. 6

Revision of Scoring on American Optical Company's Color Vision Test

Proposal sent to Captain J.C. Adams, (MC) U.S.N. by Lt. Comdr. J.G. Jenkins, A-V(S), U.S.N.R.

1. Data reaching the Bureau of Medicine and Surgery indicates that some Selection Boards are rejecting an unduly large percentage of applicants because of failure to meet standards on the subject test of color vision.
2. It is believed that this results from unwarranted rigidity in scoring responses to the individual plates.
3. A research project conducted with a large population shows that all of the following responses should be scored as correct.

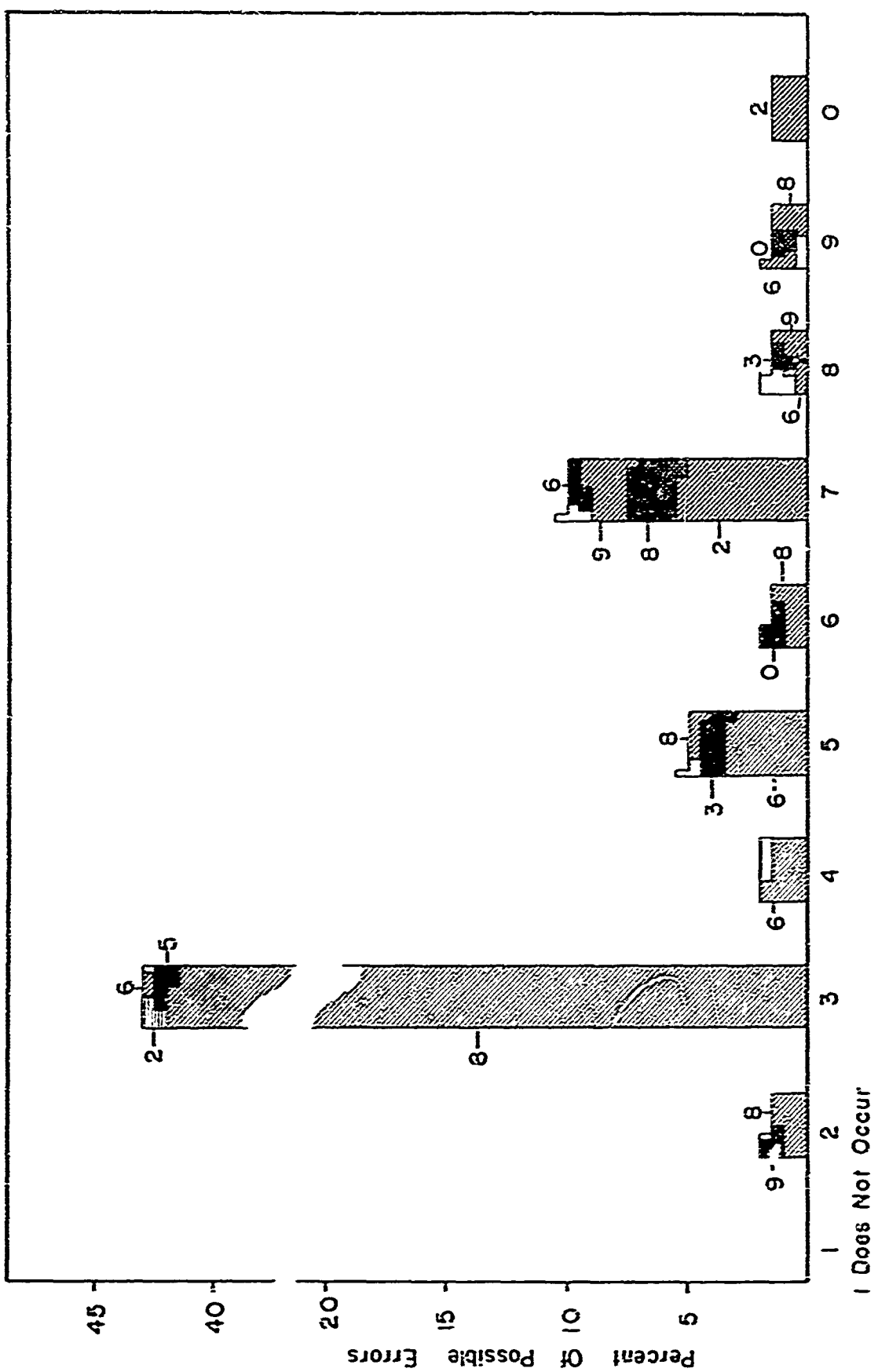
PLATE	ACCEPTABLE RESPONSES
2	43, 48
7	39, 89
11	29, 20
12	57, 37
14	75, 76
22	34, 84
28	43, 48
30	75, 25
33	No number, 45
34	No number, 73
38	394, 894
39	23, 28
40	65, 66

ILLUSTRATION NO. 7

The following table is an analysis of the number of errors made in calling the various digits on all plates in the A.O. test, except the confusion, line, and malingering plates.

200 cases

Digit	Total Possible Errors	Total Errors	Breakdown according to Erroneous Response
1	0	0	
2	1600	27	8 (20) 9 (5) 6 (1) 7 (1)
3	1200	516	8 (502) 5 (6) 2 (4) 6 (3) 9 (1)
4	1200	24	6 (14) 2 (3) 1 (2) 3 (2) 5 (2) 8 (1)
5	1800	92	6 (62) 8 (18) 3 (8) 9 (3) 4 (1)
6	1600	27	8 (18) 9 (9)
7	1400	142	2 (75) 8 (29) 9 (26) 6 (7) 0 (2) 1 (1) 5 (1)
8	1200	26	3 (9) 6 (5) 2 (5) 4 (3) 9 (2) 5 (1)
9	1400	22	8 (9) 0 (5) 6 (4) 2 (2) 3 (2)
0	200	3	2 (3)



This is the usual custom in administering this test in the Navy, that is, when an individual miscalls a plate, the operator asks him to read it again, or says "Are you sure?" or "Read that again, please." Of course, the alert subject will realize he has made a mistake and make another try, even if he guesses. Any test allowing or requiring such coaching for its proper performance is obviously unsatisfactory because of the variability of the assistance given. Great leniency in interpreting these plates has been allowed in the Jenkins proposal (see Illustration No. 6), but even this is not sufficient to eliminate the difficulties and confusion. For example, for Plate #40 the color normal response is supposed to be 65. The Jenkins proposal (Illustration No. 6) allows either 65 or 66. We find that among those individuals making errors on this plate, the most prevalent type of error is that of seeing no number at all, while a significant group give other answers (68, 05, etc.). We feel that if one incorrect response is permissible, any of these incorrect responses could conceivably be allowed with the same justification.

The Jenkins proposal allows for the miscalling of Plate #12, but does not allow for the miscalling of Plate #45. In our series twenty-five errors were made on Plate #12, and forty-nine were made on Plate #45. To be consistent, the miscalling of Plate #45 should certainly be allowed as normal.

Plate #34 is another example in point. According to the American Optical Company manual (Illustration No. 5) the normal individual "rarely" reads this plate, whereas the red-green blind ordinarily reads 73. If one allows as normal both no number or 73 (as set up in the Jenkins proposal), then we feel the plate is diagnostically valueless. In addition to the response allowed by Jenkins, there are a great number of people who called this plate 75, 23, 25, 28, and various other numbers. Is a person to be failed on this plate because he is insufficiently "color-blind", with the result that he calls the plate 75 instead of the normal red-green blind response of 23? If 73 is allowed, then any response must be considered correct

and the plate contributes only confusion.

On the basis of this study we recommend:

(1) the substitution of a more satisfactory
test for color perception;

or (2) an entire revision of the plates, simplifying
the figures and the formation of some of the
digits;

or, at least (3) the deletion of the unsatisfactory plates.

In this report, we are not giving an extensive account of any of the other tests, but will briefly mention some of the results. We have included as Illustrations No. 9, No. 10, No. 11, and No. 12 actual score sheets on representative cases on the various tests. An explanatory paragraph accompanies each illustration.

The Royal Canadian Navy Colour Vision Lantern: In our investigation of this equipment, we have tested both those who are normal and those whose color perception is defective on our other tests. The subjects being tested are given the following instructions: "Name the colors from left to right. These are simple, pure colors and should be named accordingly, that is, say red -- not maroon, or rose, or pink, etc." The subjects are not told that there are only three colors and that these are red, green and white.

As yet we have tested an insufficient number to justify any final conclusions as to the accuracy of this lamp in determining color-blindness. However, we can state that we consider the instructions accompanying the equipment seem to be inadequate, as no allowance has been made for the following specific inaccuracies often encountered with the lantern when we are testing color-normal subjects:

the green light (signal green) is sometimes called "blue",
the white light is often called "yellow", sometimes called
"orange" or "amber"

The manual accompanying the lantern allows the white to be called yellow, but makes no allowance for any other alternative. Actually, the "white" light does have a distinctly "yellow" cast. Obviously, the value of the lantern would be enhanced by a revision of the instructions to make allowance for these often-encountered inaccuracies. Except for this element of confusion, the lantern has been satisfactory as an indicator of abnormal red-green color perception. A further report on our results will be made at a later date.

Illustration No. 12 presents a case whose performance on the other tests is poor, but is perfect on the Royal Canadian Navy Colour Vision Lantern, since his anomaly is in the blue-yellow axis.

The Farnsworth test has the distinct advantage of giving a qualitative and a quantitative score, permitting statistical analysis, and an individual presentation in graphic form. The records for the four representative cases mentioned above demonstrate this feature. We are actually using this test as a means of measuring how good the other tests are.

We have no comment to make at this time concerning the other tests. A further report will be made at a later date.

ILLUSTRATION NO. 9

J.W., Civil Service candidate:

This man made most of his errors in the blue and yellow region and thus he is anomalous in the red-green, (for example, the errors in the yellow are due to his inability to distinguish various amounts of red). This is confirmed by his performance on the Royal Canadian Navy lantern in which he miscalled green, red, and white; and by his inability to read the digits on most of the plates of the American Optical Company's test. His I.S.C.C. performance is inaccurate, also.

Population

Date: 9-3-42

NAME: J. W. (Last name) First Middle Rank or Rank: —

AGE: 32 Color of Eyes: Blue Length of Service: —

Visual acuity: 20/20 Education: 8 I.Q.: —

Notes on Eyes: — Time: —

PSEUDO-ISOMETRIC PLATES:

PLATE #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Normal	X ₈₉	X ₄₃	X ₅₅	Y ₂₇	Y ₉	Y ₆	Y ₃₉	X ₄₂	X ₅₆	X ₂₇	X ₂₉	Y ₅₇	X ₈₅	X ₇₅	Y ₇	X ₉	X ₂₅
2 - G	-	-	-	-	-	-	-	-	-	-	70	-	-	-	-	-	-

PLATE #	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Normal	Y ₆₃	Y ₅	Y ₃	X ₉₇	X ₃₁	X ₅₆	Y ₂₇	Y ₁₂	Y ₁₁	X ₈₉	Y ₄₃	Y ₈₅	X ₇₅	Y ₅₂	Y ₉₅
2 - G	-	2	5	-	-	-	-	-	-	-	-	-	-	-	-

PLATE #	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Normal	---	---	X ₁₀₁	X ₁₀₁	X ₆₅₂	X ₃₉₄	Y ₂₃	Y ₆₅	Y ₁₅	Y ₇₄	Y ₄₇	X ₉₈	---	follows
2 - G	-	-	No	No	-52	99	-	-	-	-	-	-	-	-

ROYAL CANADIAN COLOR LANTERN TEST

Actual	Comb. No.	Subject Response	Actual	Comb. No.	Subj. Response
GN	1	GG	GP	8	GG
GG	2	✓	GR	8	✓
RG	3	✓	WG	9	YG
WR	4	RR	WG	9	YR
WR	4	RG	Repeat:		
WR	5	RG			
RR	6	RG			
RR	7	✓			

Name J. H. CIVIL SERVICE LABORED 25072

Date 9 13 192

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88

$2\frac{1}{2}$ minutes

Lat. Long.

Start
 End
 Report

WINDSTORM-VELOCITY-SCALE TEST
 for Color Yarn

Designed by
 MONTELL COLOR CO. INC.
 110 East Franklin Street
 Baltimore, Md.

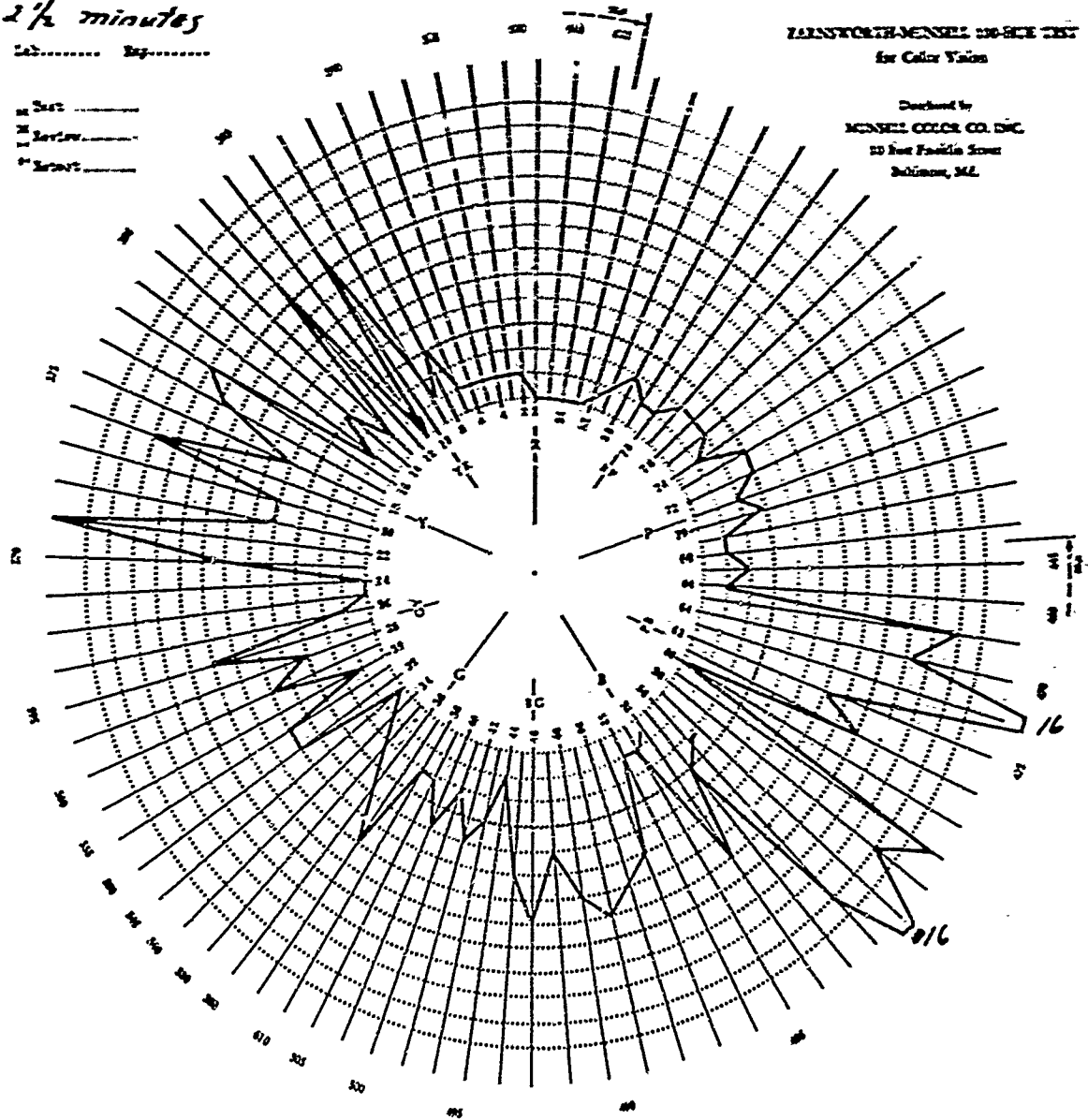


ILLUSTRATION NO. 10

W.J.F., A.S.:

This case is that of an individual who identifies the green of the Royal Canadian Navy Colour Vision Lantern as "blue". His ten errors on the American Optical Company plates are not significant and his Farnsworth performance is fair. On the I.S.C.C. he made two errors of transposition.

Recheck

Date: 8-6-42

NAME: W.J.F. Date or Rank: A.S.
(Last Name) First Middle

AGE: 20 Color of Eyes: Blue Length of Service: 1^{yr}

Visual acuity: 20/20 Education: 12 I.Q.: 116

Vision on Eyes: _____ Time: _____

PSICO-ISOMERIZED PLATES:

PLATE #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Normal	89	53	56	27	8	6	X 33	12	56	27	X 23	57	85	75	7	9	25
R - G							37				20						

PLATE #	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Normal	63	5	5	37	34	X 55	27	12	11	23	X 43	85	X 75	X 32	55
R - G						58					48		76	59	

PLATE #	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Normal	X	X	fol	fol	052	X 194	23	65	15	74	47	98	—	follows
R - G						374	—	—						

ROYAL CANADIAN MOUNTED POLICE TEST

Actual	Comb. No.	Subject Response	Actual	Comb. No.	Subj. Response
GN	1	BY	GR	8	BR
GS	2	GB	GR	6	BR
RS	3	RB	RS	9	YB
RR	4	✓	RS	9	YB
RR	4	✓	Repeat:		
RR	5	Yw			
RR	6	✓			
RR	7	✓			

Spec H. J. AS. Page 20 Date 8/16/72

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

2 1/4 minutes

Start _____
 End _____
 Time _____

WINSTON-SALEM, N.C. 27601
 For Color Vision

Designed by
 MICHAEL GILES CO. INC.
 100 New Franklin Street
 Winston, N.C.

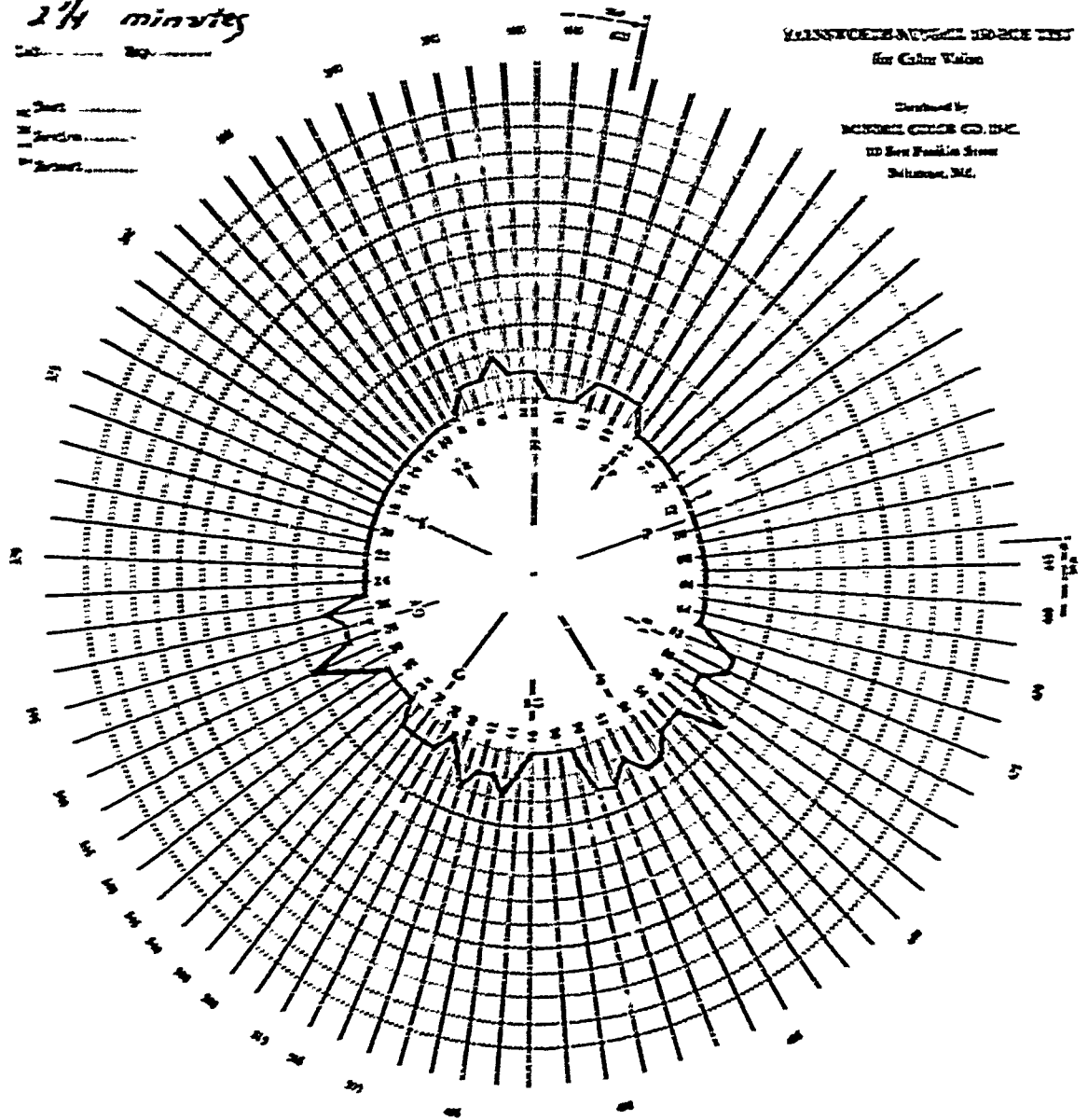


ILLUSTRATION NO. 11

R.E.G., E.M.3c:

This case is chosen as being normal on all tests except for the A-O plates. His Farnsworth performance is fair (a few errors are made by nearly everyone) and he made no errors on the R.C.N. lantern. On the I.S.C.C. test he made one error of transposition, which is not significant. His A-O performance is not good, as he miscalled twenty-six plates.

Routine Recheck

Date: 8-31-42

NAME: G R E. Date or Rank: EM 3/4
(Last Name) First Middle

AGE: 79 Color of Eyes: Brown Length of Service: 6 mo.

Visual acuity: 20/20 Education: 12 yrs. I.Q.: 89 D

Notes on Eyes: _____ Time: 3 min 10 sec

PSYCHO-ISOMETRIC PLATES:

PLATE #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Normal	✓ 68	✓ 43	✓ 55	✓ 21	✓ 9	✓ 6	✓ 35	✓ 42	✓ 55	✓ 27	✓ 23	✓ 37	✓ 65	✓ 75	✓ 7	✓ 9	✓ 25
R - G	80	68		99			89	68		97	70			76			26

PLATE #	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Normal	✓ 68	✓ 5	✓ 3	✓ 97	✓ 34	✓ 55	✓ 27	✓ 12	✓ E	✓ 69	✓ 43	✓ 65	✓ 75	✓ 52	✓ 95
R - G		8	5		36		77			-	-	-	-	-	

PLATE #	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Normal	✓ 2	✓ 2	✓ 201	✓ 101	✓ 652	✓ 394	✓ 23	✓ 65	✓ 15	✓ 74	✓ 47	✓ 53	✓ X	✓ followed
R - G					252		-	-	17	71	-	-	line	

ROYAL CANADIAN COLOR LANTERN TEST

Actual	Comb. No.	Subject Response	Actual	Comb. No.	Subj. Response
GN	1	✓	GR	8	✓
GG	2	✓	GR	8	✓
RG	3	✓	RG	9	✓
RR	4	✓	RG	9	✓
RR	4	✓	Repeat:		
RR	5	✓			
RR	6	✓			
RR	7	✓			

Name R. E. G. EM 7/6 320.17 Date 9.1.42

85	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42		
	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62		
85	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84

2 minutes

Lab. Exp.

Det.
 Refr.
 Dist.

FARNSWORTH-MINSELL 100-HUE TEST
 for Color Vision

Designed by
 MINSELL COLOR CO., INC.
 10 East Providence Street
 Baltimore, Md.

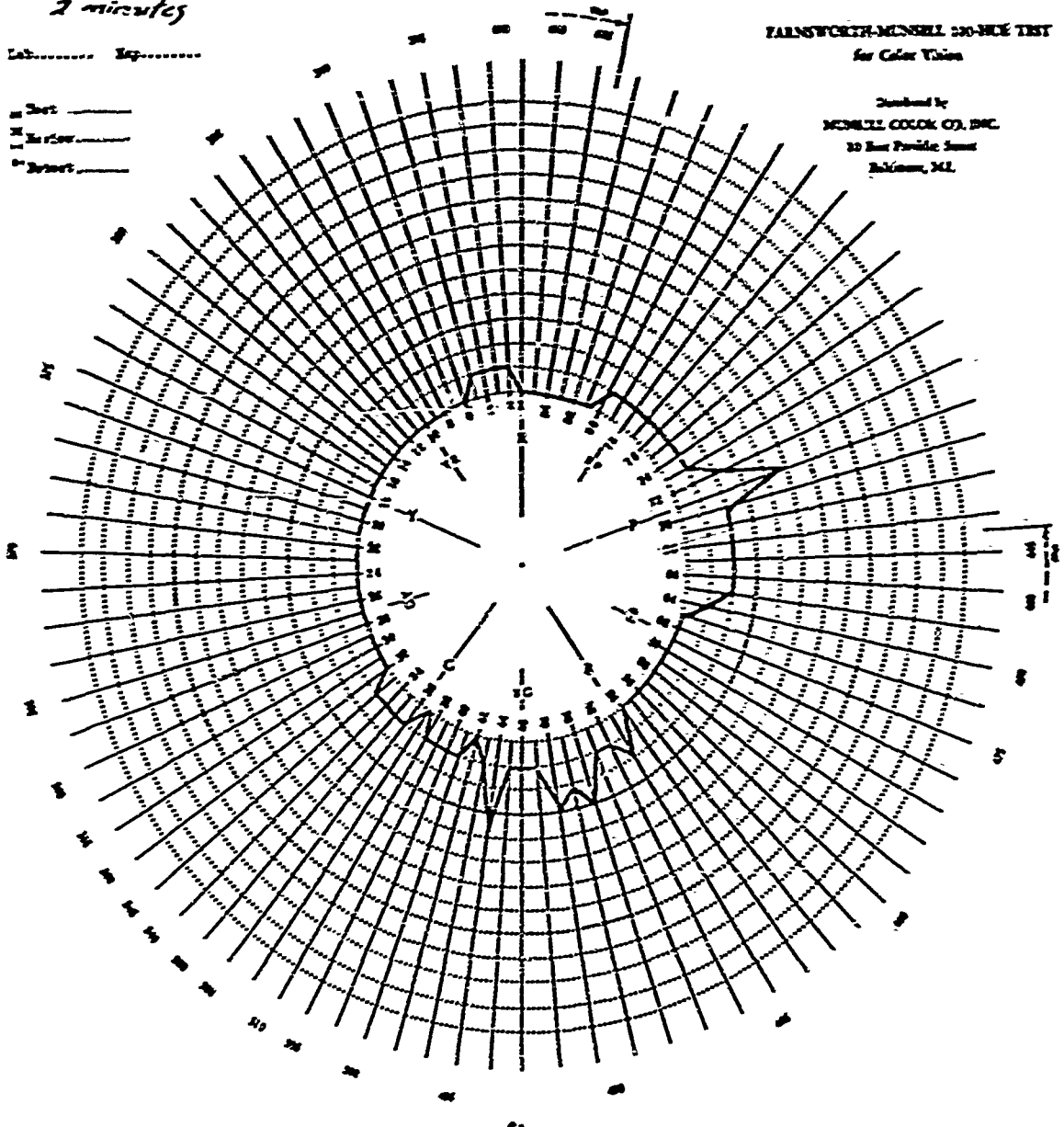


ILLUSTRATION NO. 12

E.L.I., Sea, 2c.:

This man was found to be blue-yellow blind by the Farnsworth Panel. One could not diagnose his deficiency correctly from his poor A-O performance. He made mistakes on many other plates besides those designed to catch this type of anomaly. He made no errors on the Royal Canadian Navy lantern. This man shows that the Royal Canadian Navy lantern does not screen the blue-yellow anomalous.

Recheck

Date: 7-27-42

NAME: E. I. I. Date or Rank: S 3/4
(Last name) First Middle

SE: 17 Color of Eyes: Gray Length of Service: 5 yrs

Visual acuity: 20/20 Education: 10 I.Q.: 104 A

Notes on Eyes: _____ Time: _____

PSEUDO-ISOCHEMATIC PLATES:

PLATE #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Normal	83	43	56	27	8	6	39	42	56	27	29	57	85	75	7	9	25
R - G		48				5	89	-	76	-	-	-	-	-			

PLATE #	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Normal	68	5	5	97	34	56	27	12	8	39	43	86	75	52	96
R - G	69	2	5		54	-	28			-	-	-	-		

PLATE #	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Normal	✓	--	fol	fol	052	394	23	65	15	74	47	98	✓	follows
R - G		29	No	No		894	-	-	17	21	-	-		

ROYAL CANADIAN COLOR LANTERN TEST

Actual	Comb. No.	Subject Response	Actual	Comb. No.	Subj. Response
CS	1	✓	GR	8	✓
GG	2	✓	GR	8	✓
IG	3	✓	WG	9	✓
IR	4	✓	WG	9	✓
IR	4	✓	Repeat:		
IV	5	✓			
RW	6	✓			
RR	7	✓			

Name E. L. T. S. 1/2 age 17 Date 7/31/42

14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23
61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39

2 minutes

Lab..... Exp.....

Test
Review
Retest

FARNSWORTH-MUNSELL 100-HUE TEST
for Color Vision

Distributed by
MUNSELL COLOR CO. INC.
10 East Franklin Street
Baltimore, Md.

